

ANALYSIS OF METABOLIC STATUS IN PATIENTS WITH DIABETES MELLITUS AND ITS RELATIONSHIP WITH THE SPECTRUM OF SKIN DISORDERS: A MIXED STUDY AT SYAHIRA MEDIKA CLINIC

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Abstract

Diabetes mellitus (DM) is a chronic disease frequently accompanied by cutaneous manifestations that may reflect poor metabolic control. This study aimed to analyze the association between metabolic status and the spectrum of skin disorders and to explore patients' experiences at Syahira Medika Clinic. A mixed-methods study with a sequential explanatory design was conducted among 51 patients with type 2 DM. Metabolic status was assessed using HbA1c, fasting blood glucose (FBG), total cholesterol, body mass index (BMI), and blood pressure; skin disorders were identified through clinical examination. Quantitative data were analyzed using Fisher's Exact, Chi-Square, Spearman correlation, and Mann-Whitney tests, followed by in-depth interviews with 10 selected informants and thematic analysis. Skin disorders were found in 84.3% of respondents, most commonly skin tags (31.4%), diabetic dermopathy (27.5%), and bacterial infections (25.5%). Significant associations were observed with HbA1c ($p=0.002$), FBG ($p<0.001$), total cholesterol ($p=0.023$), BMI ($p=0.007$), and blood pressure ($p=0.003$). HbA1c was positively correlated with the number of skin disorder types ($r=0.565$; $p<0.001$). Qualitative findings indicated impacts on sleep and self-confidence, while medication adherence, dietary management, and family support facilitated management. Integrated findings indicate that poor metabolic status is associated with more frequent skin disorders, supporting skin screening alongside metabolic monitoring in diabetes care.

Keywords: Cutaneous disorders; Diabetes mellitus; Fasting blood glucose; HbA1c; Metabolic status.

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, impaired insulin action, or both. Persistent metabolic disturbances in DM affect carbohydrate, lipid, and protein metabolism and contribute to various microvascular and macrovascular complications (Domenichini, 2020; Lester, 2019). The increasing burden of DM requires comprehensive disease management because complications are not limited to cardiovascular, renal, neurological, and visual disorders but also involve the skin as an important target organ (Association, 2024; Cohen et al., 2022).

Cutaneous manifestations are common among patients with diabetes and may appear as early signs, complications, or consequences of the disease and its treatment. Previous studies have reported substantial variation in the prevalence of skin disorders among patients with DM, depending on population characteristics, disease duration, and metabolic control (Bhardwaj et al., 2018; Bhelqis et al., 2024). The spectrum ranges from skin tags, diabetic dermopathy, acanthosis nigricans, xerosis, pruritus, fungal and bacterial infections to diabetic ulcers. These manifestations are clinically important because several of them are associated with metabolic abnormalities and may indicate underlying vascular, neurological, immunological, or glycemic disturbances (Cohen et al., 2022; Yosipovitch & Papoiu, 2021).

Hyperglycemia is considered one of the major mechanisms underlying cutaneous complications in diabetes. Persistent elevation of blood glucose promotes the formation of advanced glycation end products, oxidative stress, inflammation, microvascular dysfunction, and impaired immune responses. These mechanisms may interfere with skin integrity, wound healing, and resistance to infection (Gupta & Skinner, 2023). Poor glycemic control reflected

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by elevated HbA1c has therefore been associated with increased occurrence and severity of various cutaneous manifestations. Other metabolic components may also contribute to skin abnormalities. Insulin resistance and obesity are closely related to acanthosis nigricans and skin tags through hyperinsulinemia and activation of insulin-like growth factor pathways (Kutlubay et al., 2020; Rendon & Cruz, 2021). Obesity may also increase chronic inflammatory activity and impair skin barrier function. Similarly, lipid abnormalities may contribute to endothelial dysfunction and impaired tissue perfusion, potentially increasing the risk of skin complications (Mustofa et al., 2024). Hypertension may further aggravate microvascular impairment in patients with diabetes.

Several studies have documented the high frequency of specific cutaneous manifestations. Bhardwaj et al. (2018) reported that cutaneous manifestations occurred frequently among patients with diabetes, while Larissa et al. (2021) found a substantial burden of skin manifestations among patients with type 2 DM in Medan. Simanjuntak et al. (2021) also reported diabetic ulcers as an important manifestation among patients with type 2 DM. These findings demonstrate that the clinical spectrum of diabetic skin disorders may vary across populations and healthcare settings. Despite the increasing evidence concerning diabetes-related skin disorders, important gaps remain in understanding how multiple metabolic abnormalities collectively influence the spectrum of cutaneous manifestations, particularly in primary healthcare settings. Cutaneous manifestations are relatively common among patients with diabetes and may involve a broad spectrum ranging from xerosis, pruritus, acanthosis nigricans, skin tags, diabetic dermopathy, and recurrent bacterial or fungal infections to more severe conditions such as diabetic foot ulcers (Abate et al., 2025; V. Y. Chen et al., 2023; Hines et al., 2021). Recent evidence suggests that these manifestations are not merely dermatological complications but may reflect underlying metabolic disturbances, chronic hyperglycemia, insulin resistance, microvascular dysfunction, inflammation, and impaired skin barrier function (David et al., 2023; Legiawati et al., 2022). In particular, persistent hyperglycemia may induce oxidative stress, advanced glycation end products, endothelial dysfunction, and impaired cellular responses, thereby compromising skin integrity and wound-healing processes (Y. C. Chen et al., 2023).

However, previous studies have often examined individual cutaneous manifestations or isolated metabolic parameters rather than evaluating HbA1c, fasting blood glucose, lipid status, body mass index, and blood pressure simultaneously. This is important because metabolic abnormalities frequently coexist and may interact in contributing to skin damage. Evidence from primary care in Indonesia, for example, has demonstrated poorly controlled type 2 diabetes accompanied by abnormalities in HbA1c and triglycerides among patients presenting with early dry-skin disorders, highlighting the relevance of metabolic control in routine primary healthcare (Legiawati et al., 2022). Similarly, recent studies indicate that the severity of skin manifestations may increase in the presence of poor glycemic control and that recognition of specific dermatological signs can provide an opportunity for early metabolic assessment and intervention (Abate et al., 2025; Rodrigues et al., 2025).

Furthermore, diabetes-related skin disorders may have consequences that extend beyond physical symptoms. Skin alterations can impair quality of life, cause discomfort and pruritus, interfere with sleep and daily activities, and increase the psychological burden experienced by patients. The chronic hyperglycemic and insulin-resistant environment also predisposes patients to impaired wound healing and persistent inflammatory responses, particularly among those who develop diabetic foot ulcers (V. Y. Chen et al., 2023). Consequently, early identification and appropriate management of skin abnormalities should be considered an integral component of comprehensive diabetes care rather than an isolated dermatological service. Recent reviews have emphasized the importance of routine recognition of cutaneous manifestations by primary care providers because skin abnormalities may provide clinically useful clues regarding metabolic dysfunction and the risk of subsequent complications (Abate et al., 2025; David et al., 2023; Hines et al., 2021).

Another important consideration is that quantitative clinical measurements alone cannot fully capture the experience of patients living with diabetes-related skin disorders. Laboratory parameters such as HbA1c, fasting blood glucose, lipid levels, BMI, and blood pressure can demonstrate the statistical relationship between metabolic status and cutaneous manifestations, but they do not adequately explain how patients recognize their symptoms, interpret their causes, manage their conditions, or experience their effects on daily life. A mixed-methods approach is therefore particularly relevant because qualitative information can provide contextual explanations for quantitative associations and identify behavioral, psychosocial, and family-related factors that may influence disease management.

Therefore, this study was conducted at Syahira Medika Clinic to analyze the association between metabolic status and the spectrum of cutaneous disorders among patients with type 2 diabetes mellitus and to explore patients' perceptions and experiences of these conditions. The study adopted a sequential explanatory mixed-methods design, in which quantitative assessment of HbA1c, fasting blood glucose, total cholesterol, BMI, blood pressure, and skin manifestations was followed by qualitative exploration of patients' experiences. This approach allows clinical findings to be interpreted alongside patients' perceptions, self-care practices, treatment adherence, and family support.

The study is expected to contribute to a more comprehensive understanding of diabetes-related skin disorders and provide evidence for integrating metabolic monitoring, routine skin screening, patient education, preventive skincare, and early management of cutaneous complications into primary diabetes care. The importance of this integrated approach is increasingly supported by recent literature emphasizing that recognition of skin manifestations can facilitate earlier identification of metabolic deterioration and potentially reduce the progression of diabetes-related complications.

LITERATURE REVIEW

Diabetes Mellitus and Metabolic Status

Diabetes mellitus is characterized by chronic hyperglycemia resulting from abnormalities in insulin secretion, insulin action, or both (Lester, 2019). Persistent metabolic abnormalities can affect multiple organs and increase the risk of microvascular and macrovascular complications. The assessment of metabolic status in patients with diabetes therefore requires consideration of several parameters, including glycemic control, lipid profile, body composition, and blood pressure (Association, 2024). HbA1c is an important indicator of long-term glycemic control, whereas fasting blood glucose reflects the patient's glucose level at a particular time. Poor glycemic control may promote the formation of advanced glycation end products and oxidative stress, which contribute to tissue damage and impaired physiological function (Domenichini, 2020). The combination of poor glycemic control with obesity, dyslipidemia, and hypertension may increase the overall metabolic burden of patients with DM.

Cutaneous Manifestations in Diabetes Mellitus

The skin is frequently affected by diabetes. Cutaneous manifestations may be directly related to metabolic abnormalities, associated with complications, or caused by infections occurring more frequently in diabetic patients (Cohen et al., 2022). A systematic review by Bhelqis et al. (2024) indicates that the prevalence of skin disorders among patients with DM varies considerably across studies. Skin tags are benign lesions that may be associated with insulin resistance and metabolic syndrome. Hyperinsulinemia may stimulate insulin-like growth factor-1 receptors, resulting in keratinocyte and fibroblast proliferation (Kutlubay et al., 2020; Rendon & Cruz, 2021). Thus, a high prevalence of skin tags may provide an indirect clinical indication of metabolic abnormalities.

Diabetic dermopathy is another frequently reported manifestation. It generally appears as hyperpigmented macules or papules, particularly on the pretibial region, and is associated with microvascular changes occurring in diabetes (Cohen et al., 2022). Its presence may therefore reflect long-standing metabolic and vascular disturbances. Infections are also important cutaneous complications. Patients with DM have increased susceptibility to fungal and bacterial infections because hyperglycemia, impaired immune function, and impaired tissue perfusion may facilitate microbial growth and delay recovery (Bhardwaj et al., 2018; Yosipovitch & Papoiu, 2021). Xerosis and pruritus may also occur because of impaired skin barrier function, autonomic dysfunction, altered hydration, and metabolic disturbances (Kim & Cho, 2022; Yosipovitch & Papoiu, 2021). Diabetic ulcers represent one of the most serious skin-related complications. They are associated with neuropathy, ischemia, repetitive trauma, and impaired wound healing (Armstrong et al., 2020). The presence of neuropathy may reduce the patient's ability to recognize trauma, increasing the risk of chronic wounds and infection.

Relationship Between Metabolic Status and Skin Disorders

The relationship between metabolic status and skin disorders can be understood through several interconnected mechanisms. Chronic hyperglycemia promotes advanced glycation end products, oxidative stress, inflammation, and microvascular injury. These processes can alter collagen structure, reduce skin elasticity, impair immune responses, and delay wound healing (Cohen et al., 2022; Domenichini, 2020). Obesity contributes to insulin resistance and hyperinsulinemia and may promote manifestations such as acanthosis nigricans and skin tags (Kutlubay et al., 2020; Rendon & Cruz, 2021). Excess adipose tissue also produces pro-inflammatory mediators that may contribute to chronic inflammation and impaired skin barrier function. Dyslipidemia and hypertension may additionally affect the microvascular system. Endothelial dysfunction and impaired tissue perfusion can reduce oxygen and nutrient delivery to the skin, potentially increasing susceptibility to tissue damage and delaying healing (Mustofa et al., 2024). Thus, skin disorders in DM should not be considered solely dermatological problems but may represent clinical indicators of broader metabolic disturbances.

Previous Studies and Research Gap

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Previous research has demonstrated a high prevalence of cutaneous manifestations among patients with DM. Bhardwaj et al. (2018) reported a prevalence of 73.7%, whereas Bhelqis et al. (2024) reported substantial variation across populations. Studies in Indonesia have also documented different dominant manifestations, including diabetic ulcers and other skin disorders (Larissa et al., 2021; Simanjuntak, 2021). Recent research has begun to examine the association between HbA1c and skin manifestations. Putri et al. (2026), for example, reported a significant association between HbA1c and skin manifestations among patients with type 2 DM. However, evidence examining several metabolic parameters simultaneously remains limited, particularly in primary healthcare settings. The present study addresses this gap by examining HbA1c, fasting blood glucose, total cholesterol, BMI, and blood pressure in relation to the occurrence and spectrum of skin disorders. The study also adds a qualitative component to understand patients' perceptions, experiences, coping strategies, and family support. This integrated approach provides a broader understanding of the clinical and psychosocial dimensions of diabetic skin disorders.

METHOD

This study employed a mixed-methods approach with a sequential explanatory design, in which quantitative data collection and analysis were conducted first, followed by qualitative data collection to explain and deepen the quantitative findings. This approach was selected because the relationship between metabolic status and skin disorders involves both measurable clinical parameters and patients' subjective experiences. The research was conducted at Syahira Medika Clinic during September–October 2025. The population consisted of patients diagnosed with diabetes mellitus who received outpatient care at the clinic. Based on medical records, the estimated population was 103 patients. Using the sampling calculation documented in the thesis, 51 respondents were included in the study.

The quantitative variables included metabolic status and cutaneous manifestations. Metabolic status was assessed using HbA1c, fasting blood glucose, total cholesterol, BMI, and blood pressure. Skin disorders were assessed through clinical examination, including identification of the type, number, location, and characteristics of lesions. Data were obtained from medical records, laboratory examinations, physical measurements, and clinical observation. The qualitative component involved 10 informants selected purposively. Semi-structured interviews explored perceptions regarding the causes of skin disorders, effects on daily activities and quality of life, self-care strategies, treatment experiences, and expectations of healthcare services. Quantitative data were analyzed descriptively and inferentially using Chi-Square, Fisher's Exact Test, Spearman correlation, and Mann-Whitney tests. Qualitative data were analyzed thematically through transcription, familiarization, initial coding, categorization, identification of themes, and interpretation. The quantitative and qualitative findings were subsequently integrated to obtain a comprehensive interpretation.

RESULTS AND DISCUSSION

Characteristics of Respondents

The study included 51 patients with type 2 DM. Most respondents were male, 28 people (54.9%), while 23 (45.1%) were female. The largest age group was 60–69 years, comprising 22 respondents (43.1%). The most common educational level was elementary school, representing 19 respondents (37.3%). The largest proportion had lived with diabetes for 6–9 years (39.2%). The predominance of older respondents is relevant because increasing age is associated with a higher risk of type 2 DM and chronic complications. Long disease duration may also increase cumulative exposure to hyperglycemia and vascular injury, potentially increasing the likelihood of skin manifestations (Larissa et al., 2021).

Metabolic Status

The metabolic profile demonstrated considerable metabolic burden. HbA1c was uncontrolled ($\geq 7\%$) in 26 respondents (51.0%), while 46 respondents (90.2%) had elevated fasting blood glucose. Hypercholesterolemia was present in 18 respondents (35.3%). Regarding BMI, 24 respondents (47.1%) were obese and 14 (27.5%) were overweight, meaning that 74.6% had excess body weight. Hypertension was present in 37 respondents (72.5%). These findings indicate that the majority of respondents experienced one or more metabolic abnormalities. Poor glycemic control may promote advanced glycation, oxidative stress, microvascular dysfunction, and impaired immune responses, thereby increasing susceptibility to skin disorders (Association, 2024; Domenichini, 2020). The high proportion of overweight and obesity may also contribute to insulin resistance and skin manifestations associated with metabolic syndrome (Kutlubay et al., 2020; Rendon & Cruz, 2021).

Spectrum of Skin Disorders

Cutaneous manifestations were identified in 43 of 51 respondents (84.3%). The most common manifestation was skin tag, occurring in 16 respondents (31.4%), followed by diabetic dermopathy in 14 respondents (27.5%), bacterial infection in 13 respondents (25.5%), acanthosis nigricans and diabetic ulcer in 12 respondents each (23.5%), fungal infection in 10 respondents (19.6%), pruritus in 9 respondents (17.6%), and xerosis in 7 respondents (13.7%). The prevalence observed in this study is higher than the 73.7% reported by Bhardwaj et al. (2018) but falls within the broad range described in the systematic review by Bhelqis et al. (2024). Differences between studies may be related to age, disease duration, metabolic control, clinical assessment methods, and healthcare setting. The predominance of skin tags may be related to the high proportion of overweight and obese respondents. Insulin resistance and hyperinsulinemia may stimulate epidermal proliferation through insulin-like growth factor pathways, contributing to skin tag formation (Kutlubay et al., 2020; Rendon & Cruz, 2021).

Diabetic dermopathy was the second most frequent manifestation. Its occurrence may reflect chronic microvascular damage associated with diabetes (Cohen et al., 2022). Meanwhile, bacterial and fungal infections may be promoted by hyperglycemia, impaired immune function, and changes in the skin environment (Gupta & Skinner, 2023). Diabetic ulcers were found in 23.5% of respondents. This finding is clinically important because ulcers may develop through the interaction of neuropathy, ischemia, and repetitive trauma and may progress to infection and amputation if not managed appropriately (Armstrong et al., 2020). The presence of neuropathy in 35.3% of respondents further supports the importance of comprehensive foot and skin assessment.

Relationship Between HbA1c and Skin Disorders

A significant relationship was found between HbA1c category and skin disorders ($p=0.002$). All 26 respondents with uncontrolled HbA1c experienced skin disorders, whereas 17 of 25 respondents with controlled HbA1c still experienced skin disorders. Furthermore, Spearman analysis showed a significant positive correlation between HbA1c and the number of types of skin disorders ($r=0.565$; $p<0.001$). Thus, higher HbA1c was associated with a greater number of skin disorder types. The Mann-Whitney test also demonstrated a significant difference in HbA1c between respondents with and without skin disorders ($p=0.007$). This finding is consistent with Putri et al. (2026), who reported a significant association between HbA1c and cutaneous manifestations among patients with type 2 DM. Chronic hyperglycemia may promote advanced glycation end products, reactive oxygen species, inflammation, collagen damage, and impaired epidermal regeneration. These mechanisms provide a biological explanation for the observed relationship.

Relationship Between Fasting Blood Glucose and Skin Disorders

Fasting blood glucose was also significantly associated with skin disorders ($p<0.001$). Among respondents with elevated FBG, 41 of 45 (91.1%) experienced skin disorders, whereas four of five respondents with normal FBG did not experience skin disorders. Persistent hyperglycemia can impair immune function, microvascular circulation, and skin integrity. Elevated glucose levels may also create an environment that facilitates microbial growth, increasing susceptibility to fungal and bacterial infections (Bhelqis et al., 2024; Gupta & Skinner, 2023).

Relationship Between Total Cholesterol and Skin Disorders

Total cholesterol was significantly associated with skin disorders ($p=0.023$). All 18 respondents with high cholesterol experienced skin disorders. This finding suggests that lipid abnormalities may contribute to the broader metabolic environment associated with cutaneous manifestations. Dyslipidemia may contribute to endothelial dysfunction and impaired microvascular perfusion, potentially affecting skin integrity and healing. Mustofa et al. (2024) also emphasized the importance of modifiable metabolic factors in patients with diabetes.

Relationship Between BMI and Skin Disorders

BMI was significantly associated with skin disorders ($p=0.007$). All 24 obese respondents experienced skin disorders, compared with 78.6% of overweight respondents and 61.5% of respondents with normal BMI. The strong association may be related to insulin resistance and chronic low-grade inflammation. Obesity is closely associated with hyperinsulinemia, acanthosis nigricans, and skin tags, while adipose tissue can produce inflammatory mediators that influence skin barrier function (Kutlubay et al., 2020; Rendon & Cruz, 2021).

Relationship Between Blood Pressure and Skin Disorders

Blood pressure was significantly associated with skin disorders ($p=0.003$). Among 37 respondents with hypertension, 35 (94.6%) experienced skin disorders. Hypertension may aggravate microvascular dysfunction and

impair tissue perfusion. In patients with diabetes, the coexistence of hypertension and hyperglycemia may therefore increase vascular stress and potentially worsen skin integrity. The finding supports the importance of controlling cardiovascular and metabolic risk factors simultaneously.

Relationship Between Adherence, Lifestyle, and Skin Disorders

Adherence and healthy lifestyle were also significantly associated with skin disorders ($p=0.024$). Among 25 respondents classified as non-adherent, 24 (96.0%) experienced skin disorders, compared with 19 of 26 (73.1%) adherent respondents. Medication adherence, dietary regulation, physical activity, and routine monitoring are important components of diabetes management. Poor adherence can contribute to inadequate metabolic control and consequently increase the risk of chronic complications, including skin disorders.

Qualitative Findings and Patient Experience

The qualitative analysis identified four major themes: (1) patients' perceptions regarding the causes of skin disorders, (2) effects on quality of life and daily activities, (3) treatment and self-care strategies, and (4) family support in disease management. All informants perceived that their skin conditions worsened when blood glucose increased. This subjective perception was consistent with the quantitative finding that uncontrolled HbA1c was significantly associated with skin disorders. The skin manifestations also produced psychosocial effects. All informants reported effects on quality of life, particularly sleep disturbance and reduced self-confidence. This finding emphasizes that the consequences of diabetic skin disorders extend beyond physical symptoms and may affect psychological and social well-being. All informants reported using prescribed medication and attempting to regulate their diet. Family support was another important factor, particularly reminders to take medication and attend routine follow-up visits.

Integration of Quantitative and Qualitative Findings

The mixed-methods integration demonstrates convergence between objective clinical findings and patients' subjective experiences. Quantitatively, HbA1c, FBG, total cholesterol, BMI, and blood pressure were significantly associated with skin disorders. Qualitatively, patients independently recognized that deterioration in glycemic control was accompanied by worsening skin symptoms. The findings therefore support a holistic approach to diabetes management. Monitoring should not be limited to blood glucose and other metabolic indicators but should also include routine skin assessment, patient education, adherence support, and family involvement.

CONCLUSION

The study demonstrates that metabolic abnormalities are significantly associated with the occurrence of cutaneous disorders among patients with type 2 diabetes mellitus at Syahira Medika Clinic. More than half of respondents had uncontrolled HbA1c, 90.2% had elevated fasting blood glucose, 35.3% had high total cholesterol, 47.1% were obese, and 72.5% had hypertension. Cutaneous manifestations were found in 84.3% of respondents, with skin tags, diabetic dermopathy, bacterial infections, acanthosis nigricans, and diabetic ulcers being the most frequent manifestations. A significant relationship was found between skin disorders and HbA1c, fasting blood glucose, total cholesterol, BMI, and blood pressure. HbA1c also showed a moderate positive correlation with the number of skin disorder types ($r=0.565$; $p<0.001$). Qualitative findings further demonstrated that patients perceived worsening skin conditions when blood glucose increased. Skin disorders affected sleep and self-confidence, while medication adherence, dietary management, and family support were important components of disease management. These findings support the integration of routine skin screening, metabolic monitoring, preventive skincare education, adherence counseling, and family support into diabetes services. The thesis recommends that Syahira Medika develop an SOP for routine skin screening and integrate preventive skincare education into health promotion activities.

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